

Map projection
Geoidetic Reference System: 1983, North American Datum 1983
Longitude of central meridian: 70°19' W; latitude of true scale: 41°29' N
False easting: 0 m; false northing: 0 m
This map is not intended for navigational purposes.

DISCUSSION

Introduction

The Stellwagen Bank National Marine Sanctuary Mapping Project is a cooperative effort of the U.S. Geological Survey and the National Oceanic and Atmospheric Administration, with support from the University of New Brunswick and the Canadian Hydrographic Service. The multibeam echo sounder survey was conducted on four cruises over a two-year period from the fall of 1994 to the fall of 1996. This map shows one of a series of 18 quadrangle sea floor maps in which sea floor depth information is depicted in sun-illuminated or shaded relief view at a scale of 1:25,000, with topographic contours superimposed in blue. The image shows here uses a sun elevation angle of 45 degrees above the horizon from an azimuth of 250 degrees and a vertical exaggeration of four times. In effect, topographic relief is enhanced by having the sun illuminate the sea floor from a position 10 degrees west of north, so that shadows are cast on the southern flanks of seabed features. Some features in the images are artifacts of data collection. They are especially noticeable where the seabed is smooth, and they include small high and low and somewhat-looking features and patterns that are oriented parallel or perpendicular to survey tracklines. For a depiction of the topographic contour alone, and for an explanation of survey and topographic data-processing methods, see the companion map by Valentine and others (1997). Topographic contour maps of all 18 quadrangles in the map series are available on a CD-ROM in EPS, PS, Arc export, and PDF file formats (Valentine and others, 1998). Blank areas represent places where no data exist.

Regional seabed features

The major topographic features depicted in the map series were formed by glacial processes. In broad terms, these features are interpreted here to represent a glacial history that developed in several stages. Ice-containing rock debris moved across the region, sculpting in surface and depositing sediment to form the large basins, banks, ridges, and valleys. Many other features observed here represent the later stages of deglaciation. They are the result of processes at work when much of the area was covered by stationary retreating ice, and when at the same time small valley glaciers and ice falls were active in and near areas of high topographic relief. The sea invaded the region formerly occupied by ice, and seabed features were partly eroded and some

new sedimentary deposits formed. Today, the sea floor is modified mainly by strong southwesterly-flowing bottom currents caused by storm winds from the northeast. These currents erode sediments from the shallow banks and transport them into the basins. With time, the banks affected by these currents become narrower, as sand and mud are removed and gravel remains; and the western flanks of the banks, as well as adjacent basins, are built up by deposits of mud and sand.

Quadrangle 11 features

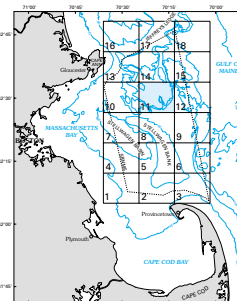
Quadrangle 11 covers the northern part of Stellwagen Bank (60 to 75 m water depth) and a topographically varied region to the north of the bank that is characterized by banks and complex ridges whose summits lie at 60 to 90 m water depth, separated by deep valleys and basins whose depth ranges between 120 to 195 m. In the southern part of the quadrangle, Stellwagen Bank is relatively flat except where it is incised by generally north-trending glacial valleys. The bank surface here is chiefly gravel and includes boulder piles and ridges. Some of these short linear ridges resemble eskers (sand and gravel deposited by melting water in channels within stationary glacial ice); they are located along the southern margin (70°19' W) and in the southeast corner of the quadrangle. Other, larger ridges are located along the upper walls of both shallow and deep glacial valleys in the southwestern part of the quadrangle (42°26.9' N, 70°20.4' W; 42°27.6' N, 70°23.1' W); these ridges are interpreted to be lateral moraine deposits of rock debris piled up at the edges of retreating ice. The northern flank of Stellwagen Bank, below 65-75 m water depth, and the shallow valleys in the southwestern part of the quadrangle are sandy, becoming muddy with increasing depth into the basin to the north. Sand deposits that display east-west-trending bedforms are located on the northern flank between 70°17' and 70°19' W and between 70°21' and 70°22' W. Broad depressions in the seabed along the eastern margin of the quadrangle, extending from the southeast corner to 42°30' N, possibly indicate the former locations of large masses of melting ice. The sea floor here is chiefly gravel, in places partly covered by a thin veneer of sand. Two deep valleys that incise the bank in the southwestern part of the quadrangle are floored with muddy sand. In the larger of these valleys, which banks at 70°20.5' W at the southern edge of the quadrangle, the floor is smooth to a depth of 115 m, from where it displays low ridges and mounds that clog the valley as it proceeds northeast into a large basin north of 42°29.3' N. The ridges and mounds possibly represent deposits of gravely glacial debris transported by ice flows down the

steep west wall of the valley. These deposits now are covered with muddy sand. The other valley, which banks at 70°24.5' W, is shorter and has a relatively smooth floor.

The rugged topography of the central and northern parts of the quadrangle displays a regional southeast-trending grain imposed by the direction of movement of the glacial ice sheet. Deep southeast-trending basins separate the banks and ridges. The relatively smooth basin floors are interrupted in some places by small elongate banks (for example, at 42°30.4' N, 70°23.9' W, and 42°32.5' N, 70°18.9' W) that are aligned with the basins. The regional grain was modified during the late stages of the last glaciation by the movement of small valley glaciers and ice falls and by the melting of masses of stationary ice. Resulting topographic features include well-defined banks with steep flanks and flat tops, and complex ridges, also with relatively steep flanks, whose surfaces have been dissected by erosion into many small valleys and rounded hills. The flat topped banks (42°33' N, 70°24' W, and 42°29.7' N, 70°17.7' W) are covered with sandy gravel and gravel, including boulder piles and ridges. Many hummocky, lobe-shaped depositional features extend from the bases of banks and ridges into the adjacent valleys and basins. They are interpreted to have been formed by glacial debris flows covered by muddy sand that was deposited by ice falls that flowed from the elevated surfaces of the banks and ridges. Several good examples of ice-fall deposits lie on the perimeter of the large bank in the northeast corner of the quadrangle (42°33' N, 70°24' W). Two complex ridges trend southeast from the northern margin of the quadrangle (70°17' and 70°21' W) and display a wide range of topographic features: hills, valleys, and small basins and related sediment types. Generally, hills are covered with gravel, valleys are sandy, and small basins are muddy sand. The floors of the large basins in this quadrangle are covered with mud that becomes sandy near the perimeters of banks and ridges.

REFERENCES CITED

Valentine, P.C., Baker, J.L., Unger, T.S., and Roworth, E.T., 1997, Sea floor topography of Quadrangle 11 in the Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 97-684, scale 1:25,000.
Valentine, P.C., Baker, J.L., Unger, T.S., and Pollock, C., 1998, Sea floor topographic map and perspective-view imagery of Quadrangles 1-18, Stellwagen Bank National Marine Sanctuary off Boston, Massachusetts: U.S. Geological Survey Open-File Report 98-138, 1 CD-ROM.



Location map outlining the 18 quadrangles in this series. Quadrangle 11 shown in blue. Stellwagen Bank National Marine Sanctuary (SBNMS) boundary indicated by dashed line. Bathymetric contours in meters.

SUN-ILLUMINATED SEA FLOOR TOPOGRAPHY OF QUADRANGLE 11 IN THE STELLWAGEN BANK NATIONAL MARINE SANCTUARY OFF BOSTON, MASSACHUSETTS

By

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